You now have such a flask with an elongated neck as is figured in the text-books, but with the advantage that, the neck being in two pieces, the potash can be introduced in the manner described with the greatest ease. As the carbon dioxide is evolved, it, of course, sinks and is absorbed by the alkali, the diminution in volume of the air within the flask being shown by the corresponding rise of the mercury in the neck. The tube being graduated, this absorption can be readily observed and noted.

The apparatus is so simple and so quickly and cheaply put together, that several may be set up side by side for comparison of the respiration of different plant organs under different conditions. There are certain errors to be guarded against. The rise of the column within the neck should be read from the mercury surface and not from that of the potash above it, since the latter absorbs water as well as carbon dioxide. Great change of temperature should also be guarded against, since it alters the volume of gas within the flask, and to this the apparatus is very sensitive. If the volume of the flask and neck, less the contents, be taken, the proper correction for temperature variation may be applied. There is also an error introduced by the variation of vapor tension due to the possible change of the moisture in the enclosed air, but this is not considerable. Such a union by a ground joint is vastly to be preferred to cutting off the flaring mouth of the flask and uniting it to a tube by a rubber joint. The manipulation of a rubber tube of such size and under such conditions is annoying in the extreme. The ground joint prepared as above and well sealed with vaseline has proved itself to be entirely air-tight.

THRIVING UNDER DIFFICULTIES

By David Griffiths

A sewer pipe three feet underground is not only uninviting but rather an unusual object of botanical study. Yet associated with such a structure on the campus of the University of Arizona, the workmen uncovered one of the most interesting struggles for ex-

istence the writer has seen for some time. The sewer system, which was put in eight or ten years ago, is of a most primitive character, being simply a drain pipe leading from the laboratories into a small ravine which finally finds its way into the Santa Cruz. The pipe consists of short sections of tiling, with no shoulders, placed end to end as closely as circumstances would permit, no cement at all being used on the joints. This pipe was laid about three feet under the surface through a hard calcareous subsoil commonly designated by the Spanish name, *caliche*. After the pipe was placed in position the trench was filled with the white hard chunks of *caliche* together with pieces of brick and scraps of iron and tin, refuse from the construction of the building.

This pipe recently became clogged, necessitating the removal of a large portion of the tiling. While the laborers were excavating, they discovered, just above the pipe and running parallel with it, an unusually large contorted root which excited their curiosity. This proved upon examination to be the root of a Virginia creeper situated at a distance of nine feet from one end of the trench. It had followed the wall of the building as far as the tiling, turned an obtuse angle and then proceeded to follow the pipe across the campus. The débris and hard masses of *caliche* caused it to become exceedingly twisted and contorted, but strange as it seemed to me the contortions were mainly in one plane approximately parallel to the surface. In no instance was the root in actual contact with the pipe, but it followed directly above it at a distance of one to two inches. Laterals, however, were freely given off toward the pipe and in two instances small roots were found actually entering between the joints of the tiling and projecting into the lumen.

The clogging of the pipe was due in a very large measure to the entrance of the roots of plants which penetrated mainly from the top and sides, forming dense mats around all the crevices. All roots, whether isolated or in clusters, were imbedded in a black slimy deposit characteristic of such locations.

There is nothing surprising in the fact that roots in this arid region should penetrate into such a structure as that described

above in search of moisture ; but when we remember that this small pipe, four inches in diameter, drains two chemical laboratories running at their full capacity during the entire school year, a different aspect is placed on the phenomenon. No less than 150 pounds of sulphuric acid alone pass through the pipe during the year. Of course there are solutions of other acids and salts in corresponding quantities. At certain times in the year and indeed at different hours of the day, solutions of poisonous chemicals of considerable density must pass down this pipe and bathe the roots which project into it.

There are probably two reasons why the large root of the Virginia creeper should follow the pipe. It found along this path considerable moisture and but slight resistance compared with the hard undisturbed *caliche* on the outside of the trench. But since we are naturally led to suppose that its main object was a search for water, we may inquire why it did not follow the pipe closely instead of remaining at a distance of one to two inches. The probable explanation for this is that it kept a safe distance from the poisonous chemicals which flow down the pipe and that the small quantities which ooze through the loose joints are reacted upon to some extent by the soil which renders them less harmful. Possibly the laterals which entered the pipe did so at a time when the quantity of chemicals in solution was at a minimum, as is the case during the summer months. One of the rootlets which entered the pipe a distance of half an inch was in apparently a perfectly healthy condition but the other which entered a distance of fully an inch had its end blackened and dead.

The roots which formed a mat around the joints and were the chief agents in clogging the pipe proved to be those of Bermuda grass (*Capriola Dactylon*) a plant which does not appear at all choice with reference to what it drinks, for it is known to thrive in the Southwest in localities where alkali is very abundant. Among other plants growing in the vicinity and which doubtless contributed to some extent to the clogging may be mentioned burr clover, alfalfa and rescue grass.

University of Arizona, February, 1901.